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Summary

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L4: Entry 4 of 10

File: USPT

Jun 16, 1998

DOCUMENT-IDENTIFIER: US 5766926 A

TITLE: Pitch degradation with wood colonizing bacteria

Brief Summary Paragraph Right (7):

Certain white-rot fungi have been also found useful in degrading pitch in pulps and pulpwoods, and particularly in non-sterile substrates, as described in U.S. Ser. No. 08/034,443, filed Mar. 19, 1993, the abandoned parent of U.S. Ser. No. 08/333,691, filed Nov. 3, 1994, now U.S. Pat. No. 5,476,790.

Brief Summary Paragraph Right (10):

Resin or pitch is a significant constituent of both softwoods, including pine, such as southern pine, loblolly pine, red pine, slash pine, spruce, fir and other conifers and hardwoods, such as eucalyptus, Betula and Populus, and it may comprise as much as 8% weight percent or even more of the feed sent to mechanical or chemical pulping processes, generally 1.5 to 4.0% for most woods used for pulping. Softwoods generally contain more resin than hardwoods, with pines having among the highest resin content among softwoods. In hardwoods, resin is located primarily in the ray cells which form much of the fiber fraction when wood is pulped. In softwoods, resin is contained in both the ray cells and also in resin ducts.

Brief Summary Paragraph Right (39):

The bacteria employed in this invention are indicated to infect a wide variety of wood types or genera processed by industry for wood products, used, for example, to make lumber, crates, barrels and pallets, structural woods, used, for example, to make furniture, paper products and the like. These include both Gymnosperms and Angiosperms, and in particular both hardwoods and softwoods. Particular classes or types of wood therefore include without limitation conifers such as firs, spruce, pines and cedars and hardwoods such as oak, maple, aspen, hickory, beech, eucalyptus and birch. Gymnosperms or softwoods such as pines generally have high pitch content and are readily colonized by the pitch degrading bacteria. Hardwoods, particularly those with low pitch contents, may in some instances require more thorough or high dose inoculation of the pitch degrading bacteria. In order to ensure optimum germination and/or bacterial growth, bacterial nutrients may be also applied to the log or wood in such cases, although the use of nutrients is generally unnecessary and less preferred.

Brief Summary Paragraph Table (1):

TABLE A	Bacteria Isolate	Gram	Culture	Source
Staining	Shape	Oxidase	Lipase	
negative	rods	positive	positive	Southern Virginia U.S.A. B-5 loblolly pine
positive	rods	positive	positive	Southern Virginia U.S.A. B-18 loblolly pine, negative
positive	rods	positive	positive	Southern Virginia U.S.A. B-24 Rothschild, negative rods positive
positive	rods	positive	positive	Wisconsin, USA aspen B-29 Southern negative rods negative positive Virginia,
positive	rods	positive	positive	USA loblolly pine B-36 Shotton Wales, negative rods positive positive UK spruce B-56
positive	rods	positive	positive	Birch positive chain positive positive* B-58 Brazil, negative rods negative positive
positive	rods	positive	positive	<u>eucalyptus</u> B-70 red pine, negative rods positive positive Minnesota B-71 slash pine,
positive	rods	positive	positive	negative rods positive positive Brazil B-74 fir, negative rods positive positive
positive	rods	positive	positive	Washington *NRRL result was negative

Detailed Description Paragraph Right (38):

The purpose of this study was to determine if bacterial isolates *Pseudomonas fluorescens* B-5, *Xanthomonas campestris* B-29 and *Pantoea* (*Enterobacter*) *agglomerans* B-58 could reduce the amount of extractives in nonsterile eucalyptus chips after a two week period by adding bacterial cells in deionized water.

Detailed Description Paragraph Right (39):

Bacteria were grown in flasks of nutrient broth for 56 hours on an orbital shaker. Each isolate was thereafter centrifuged to collect the bacterial cells and to remove spent nutrient broth. Cells from each isolate (2.8.times.10.sup.10 cells/ml of B-5, 5.9.times.10.sup.10 cells/ml of B-29 and 3.6.times.10.sup.10 cells/ml of B-58) were placed in 100 ml of deionized water and poured into a bag with 500 g (wet weight) of

nonsterile eucalyptus chips. (An additional 50 ml of deionized water with no bacterial cells were added to each bag because the eucalyptus chips were dry.) The bags with chips were then shaken to distribute inoculum evenly. One hundred and fifty ml of water was added with no bacterial cells for a control.

Detailed Description Paragraph Right (40):

After two weeks, several eucalyptus chips from each bag were removed and isolation made on nutrient agar. Bacteria with similar cultural characteristics as *Pseudomonas fluorescens* B-5, *Xanthomonas campestris* B-29 and *Pantoea* (*Enterobacter*) agglomerans B-58 were recovered from each bag of chips into which they were inoculated. Chips were air dried and the amount of solvent-soluble, non-volatile material (resin) was determined by ethanol-toluene extractive analysis. Also, two bags of 500 g of fresh frozen aspen chips were used to determine the original amount of resin at time zero. One ethanol-toluene extractive analysis was done for each 500 g bag of chips and the average of two replications from each treatment was taken to determine percent extractives (Table 14).

Detailed Description Paragraph Table (15):

TABLE 14				Percent ethanol-toluene extractives			
(ET) measured in nonsterile bacterial treated and nontreated <u>eucalyptus</u> chips. ET %							
Time	Standard	Treatment	Days	Mean	Deviation	%	Extractives Removed
				Frozen control 0 1.80 0.07 -- Aged Control 14			
1.40	0.00	22.2 (with water)	<i>Pantoea</i> 14	1.10	0.03	38.8	(<i>Enterobacter</i>) agglomerans B-58



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L1: Entry 8 of 19

File: USPT

Apr 15, 1997

DOCUMENT-IDENTIFIER: US 5620564 A

TITLE: Method of enhancing biopulping efficacy

Abstract Paragraph Left (1):

A method of making a wood pulp is disclosed. The method includes chipping wood into wood chips and then inoculating the wood chips with an inoculum of Ceriporiopsis subvermispora and a nutrient adjuvant selected from the group consisting of corn steep liquor, molasses and yeast extract. The wood chips are introduced into a bioreactor and incubated. The incubated wood chips are then pulped. A method of pretreating wood including chipping the wood into wood chips and inoculating the wood chips with an inoculum of Ceriporiopsis subvermispora and a nutrient adjuvant of corn steep liquor is also disclosed. A method for producing paper from the treated wood chips is also disclosed. The addition of the corn steep liquor nutrient adjuvant dramatically reduces the amount of fungal inoculant needed (by multiple orders of magnitude), to achieve similar results.

Brief Summary Paragraph Right (1):

In general, the field of the present invention is the biopulping of wood. In particular, the field of the present invention is biopulping of wood with Ceriporiopsis subvermispora and a nutrient adjuvant.

Brief Summary Paragraph Right (7):

U.S. Pat. No. 5,055,159 discloses biopulping with Ceriporiopsis subvermispora. Biomechanical pulping of both hardwood and softwood chips with this white-rot fungus has been demonstrated. During this process at a laboratory scale, fungal pretreatment of both hardwood and softwood species saves substantial amounts of the electrical energy during refining, improve paper strength, and reduce the environmental impact of pulping (Akhtar, et al., "Biomechanical pulping of loblolly pine with different strains of the white-rot fungus Ceriporiopsis subvermispora," Tappi J. 75:105-109, 1992; Akhtar, et al., "Biomechanical pulping of loblolly pine chips with selected white-rot fungi," Holzforschung 47:36-40, 1993; Akhtar, et al., "Biomechanical pulping of aspen wood chips with three strains of Ceriporiopsis subvermispora," Holzforschung 48:199-202, 1994; Kirk et al., "Biopulping: A Glimpse of the Future?", Res. Rep. FPL-RP-523, Madison, Wis. pp. 74, 1993). These results show the technical feasibility of biopulping.

Brief Summary Paragraph Right (9):

The present invention is a method of making a wood pulp. The method comprises inoculating wood chips with an inoculum of Ceriporiopsis subvermispora and a nutrient adjuvant. The nutrient adjuvant is selected from the group consisting of corn steep liquor, molasses and yeast extract. The wood chips are introduced into a bioreactor either before or after inoculation and incubated under conditions favoring the propagation of the fungus. After a sufficient amount of time the fungus modifies a significant amount of lignin naturally present in the wood chips. The chips are then pulped.

Detailed Description Paragraph Right (1):

The present invention is a method of biopulping using a combination of Ceriporiopsis subvermispora and a nutrient adjuvant to inoculate wood chips. Use of a nutrient adjuvant, as described below, enables one to dramatically decrease the amount of fungal inoculum (calculated on a dry weight basis as a proportion of the amount of wood chips) from 0.3% to 0.0005% while achieving comparable efficacy. This 600-fold reduction in the amount of inoculum is important in making biopulping technology economically feasible.

Detailed Description Paragraph Right (7):

Separately from the chips, a seed inoculum must be maintained of the fungal culture to be utilized during the biopulping process. The preferred culture is any useful strain of the fungal species Ceriporiopsis subvermispora, with one preferred strain being

strain CZ-3 available from the Center for Forest Mycology Research of the Forest Products Laboratory, U.S. Department of Agriculture. However, almost all other strains of Ceriporiopsis subvermispora are also suitable for the present invention. Other preferred strains are the haploid Ceriporiopsis subvermispora strains FP-105752 SS-4, L-14807 SS-1, L-14807 SS-3, L-14807 SS-S, and L-14807 SS-10 which are also obtainable from the Center for Forest Mycology Research, USDA Forest Products Laboratory, Madison, Wis. (Our experiments below demonstrate that two of the haploid strains gave more energy savings and strength improvements than the diploid CZ-3 strain.) Ceriporiopsis subvermispora strains are common in the environment and can readily be isolated from the wild.

Detailed Description Paragraph Right (8):

Strains of Ceriporiopsis subvermispora can be maintained by conventional fungal culture techniques, most conveniently by growing on potato dextrose agar (PDA) slants. Stock slants may routinely be prepared from an original culture for routine use and may be refrigerated until used.

Detailed Description Paragraph Right (49):

Fungus: The biopulping fungus Ceriporiopsis subvermispora strain CZ-3 was used. This culture was obtained from the Center for Forest Mycology Research of the USDA Forest Products Laboratory, Madison, Wis. The culture was continuously maintained in cereal culture and potato dextrose agar slants. Working cultures were prepared from the stock cultures as needed and refrigerated until used. Potato dextrose agar plate culture was inoculated from a working culture and incubated at 27.degree. C. and 65% relative humidity for 10 days.

Detailed Description Paragraph Right (72):

Objective: To compare haploid strains with that of the best diploid strain of Ceriporiopsis subvermispora (CZ-3).

Detailed Description Paragraph Right (74):

Fungus: Strain CZ-3 of Ceriporiopsis subvermispora gave us good energy savings, but no strength improvements with the use of 1% corn steep liquor and 0.0005% inoculum. This strain was a diploid. In order to save energy and improve paper strength, we started screening haploid strains (single basidiospore isolates) of Ceriporiopsis subvermispora. Five different haploid strains (FP-105752 SS-4, L-14807 SS-1, L-14807 SS-3, L-14807 SS-S, L-14807 SS-10) were obtained from the Center for Forest Mycology Research, USDA Forest Products Laboratory, Madison, Wis. Inoculum was prepared the same way as described in Example 1. The biopulping performance of these haploid strains was compared with that of diploid CZ-3 strain.

Detailed Description Paragraph Right (76):

Results: Table 4 reports the results. Diploid strain of Ceriporiopsis subvermispora (CZ-3) saved 15% of electrical energy and improved tear index by 14% compared to the control. All haploid strains performed better than the diploid strain. Two haploid strains. L14807 SS-3 and L-14807 SS-5 saved 28-29% electrical energy and increased tear index by 21-22% compared to the control.

Detailed Description Paragraph Right (79):

Objective: To evaluate the biopulping performance of haploid strain of Ceriporiopsis subvermispora (L-14807 SS3) on aspen wood chips in the presence of sterilized and unsterilized corn steep liquor.

Detailed Description Paragraph Right (84):

Objective: To evaluate the biopulping performance of haploid strain of Ceriporiopsis subvermispora (L-14807 SS-3) on loblolly pine chips in the presence of unsterilized corn steep liquor.

Detailed Description Paragraph Right (96):

Objective: To determine the biopulping efficacy of haploid isolate of Ceriporiopsis subvermispora (L-14807 SS-3) using unsterilized yeast extract and molasses.

Detailed Description Paragraph Table (2):

TABLE 1 Energy savings and strength properties during biomechanical pulping of loblolly pine chips with Ceriporiopsis subvermispora CZ-3 (2-week incubation). Treatments Strength properties (% inoculum on Burst index Tear index dry weight basis) Energy savings (%) .sup.a (kN/g) (mNm.sup.2 /g)

Control	--	.62	+-	.05	sup.b	1.67	+-	.13	.01
4	.63	+-	.04	1.89	+-	.09	.05	11	.71
	+-	.04	2.16	+-	.20	.10	12	.74	+-
									.03
									2.13

.+- .14 .15 12 .70 .+- .06 2.04 .+- .15 .30 19 .70 .+- .05 2.14 .+- .15
 .sup.a Energy savings are calculated based on
 the untreated control value .sup.b Standard Deviation

Detailed Description Paragraph Table (3):

TABLE 2 Energy savings and strength properties during biomechanical pulping of loblolly pine chips with three levels of inoculum of Ceriporiopsis subvermispura CZ-3 in the presence of two levels of corn steep liquor (CSL) from Corn Products (batch E802) (2-week incubation). Treatments Strength properties (% inoculum or CSL Energy Burst index Tear index on dry weight basis) savings (%).sup.a (kN/g) (mNm.sup.2 /g) Control -- .65 .+- .03.sup.b 2.12 .+- .20 Control + 1% CSL -- .67 .+- .02 2.07 .+- .10 .002% inoculum + 18 .72 .+- .05 2.17 .+- .12 1% CSL .001% inoculum + 19 .71 .+- .05 2.35 .+- .17 1% CSL .0005% inoculum + 18 .74 .+- .04 2.15 .+- .11 1% CSL .0005% inoculum - 1% CSL.sup.c .002% inoculum + 30 .76 .+- .04 2.37 .+- .13 3% CSL .001% inoculum + 25 .74 .+- .04 2.18 .+- .12 3% CSL .0005% inoculum + 25 .82 .+- .06 2.27 .+- .15 3% CSL .sup.a Energy savings are calculated based on the untreated control value .sup.b Standard Deviation .sup.c Fungus did not grow

Detailed Description Paragraph Table (4):

TABLE 3 Dry weight of CZ-3 strain of Ceriporiopsis subvermispura on sterilized corn steep liquor (CSL) (2-week incubation). Treatments Dry weight of fungus (mg/flask) 1% CSL (dry wt. basis) 410 3% CSL (dry wt. basis) 1060

Detailed Description Paragraph Table (5):

TABLE 4 Energy savings and strength properties during biomechanical pulping of loblolly pine chips using .0005% inoculum (dry weight basis) of diploid (CZ-3) and haploid strains of Ceriporiopsis subvermispura in the presence of 1% corn steep liquor from Corn Products (batch E802) (2-week incubation). Strength properties Energy Burst index Tear index Treatments savings (%).sup.a (kN/g) (mNm.sup.2 /g) Control -- .69 .+- .05.sup.b 2.07 .+- .13 CZ-3 15 .67 .+- .05 2.37 .+- .09 FP-105752 SS-4 22 .68 .+- .07 2.36 .+- .13 L-14807-SS-1 18 .65 .+- .05 2.35 .+- .13 L-14807-SS-3 29 .67 .+- .06 2.50 .+- .17 L-14807-SS-5 28 .63 .+- .04 2.53 .+- .12 L-14807-SS-10 22 .68 .+- .05 2.29 .+- .13 .sup.a Energy savings are calculated based on the untreated control value .sup.b Standard Deviation

Detailed Description Paragraph Table (6):

TABLE 5 Energy savings and strength properties during biomechanical pulping of aspen wood chips using .0005% inoculum (dry weight basis) of L-14803 SS-3 haploid strain of Ceriporiopsis subvermispura (Treatment) in the presence of sterilized and unsterilized 1% corn steep liquor (CSL) from Corn Products (batch E802) (2- and 4-week incubation). Strength properties Energy Burst index Tear index Treatments savings (%).sup.a (kN/g) (mNm.sup.2 /g) 2-week incubation Control -- 1.01 .+- .05.sup.b 2.16 .+- .20 Treatment 15 1.11 .+- .07 2.49 .+- .16 (sterilized CSL) Treatment 13 1.11 .+- .04 2.37 .+- .23 (unsterilized CSL) 4-week incubation Control -- 1.08 .+- .04 2.14 .+- .12 Treatment 35 1.33 .+- .05 3.13 .+- .20 (sterilized CSL) Treatment 37 1.31 .+- .07 3.16 .+- .14 (unsterilized CSL) .sup.a Energy savings are calculated based on the untreated control value .sup.b Standard Deviation

Detailed Description Paragraph Table (7):

TABLE 6 Energy savings and strength properties during biomechanical pulping of loblolly pine chips using .0005% inoculum (dry weight basis) of L-14803 SS-3 haploid strain of Ceriporiopsis subvermispura (Treatment) in the presence of unsterilized 1% corn steep liquor from Corn Products (batch E802) (2-week incubation). Strength properties Burst index Tear index Treatments Energy savings (%).sup.a (kN/g) (mNm.sup.2 /g) Control -- .61 .+- .05.sup.b 1.81 .+- .12 Treatment 38 .70 .+- .04 2.73 .+- .14 .sup.a Energy savings are calculated based on the untreated control value .sup.b Standard Deviation

Detailed Description Paragraph Table (8):

TABLE 7 Dry weight of L-14807 SS-3 haploid strain of Ceriporiopsis subvermispura on sterilized and unsterilized corn steep liquor

(CSL) (2-week incubation). Treatments Dry weight of fungus (mg/flask)
 _____ Sterilized CSL 425 Unsterilized CSL 190

Detailed Description Paragraph Table (9):

TABLE 8 _____ Dry weight of L-14807 SS-3 haploid strain of Ceriporiopsis subvermispora on sterilized and unsterilized yeast extract and molasses (2-week incubation). Treatments Dry weight of fungus (mg/flask)
 _____ Yeast extract Sterilized 305 Unsterilized 0
 Molasses Sterilized 365 Unsterilized 230 _____

Detailed Description Paragraph Table (10):

TABLE 9 _____ Energy savings and strength properties during biomechanical pulping of loblolly pine chips using .0005% inoculum (dry weight basis) of haploid strain (L-14807 SS-3) of Ceriporiopsis subvermispora in the presence of unsterilized 0.5% yeast extract and molasses on a dry weight basis (2-week incubation). Strength properties Burst index Tear index Treatments Energy savings (%) .sup.a (kN/g) (mNm.sup.2 /g) _____ Control -- .55
 .+- .03 .sup.b 1.81 .+- .10 Yeast extract 14 .59 .+- .03 2.28 .+- .08 Molasses 20
 .65 .+- .06 2.41 .+- .13 _____ .sup.a Energy savings
 are calculated based on the untreated control value .sup.b Standard Deviation

Other Reference Publication (5):

Akhtar, et al., "Biomechanical pulping of loblolly pine with different strains of the white-rot fungus Ceriporiopsis subvermispora," TAPPI J. 75:105-109 (1992).

CLAIMS:

1. A method of making a wood pulp comprising the steps of:

(a) chipping wood into wood chips;

(b) inoculating the wood chips with a liquid inoculum of Ceriporiopsis subvermispora and corn steep liquor;

(c) introducing the wood chips into a bioreactor, wherein step (c) may take place before or after step (b);

(d) incubating the wood chips under conditions favoring the propagation of the fungus through the wood chips for a sufficient amount of time for the fungus to modify a significant amount of the lignin naturally present in the wood chips; and

(e) mechanically pulping the wood chips degraded by the fungus into a paper pulp.

12. A method of pretreating wood so that the wood may be made into pulp more efficiently comprising the steps of:

(a) chipping the wood into wood chips, and

(b) inoculating the wood chips with a liquid inoculant of Ceriporiopsis subvermispora and corn steep liquor.

13. A method for producing paper comprising the steps of:

(a) inoculating wood chips with a liquid inoculant of Ceriporiopsis subvermispora and unsterilized corn steep liquor;

(b) introducing the wood chips into a bioreactor; wherein step (b) may take place before or after step (a);

(c) incubating the wood chips under conditions favorable to the propagation of the fungus through the wood chips;

(d) pulping the incubated wood chips to a selected level of freeness of fibers in the pulp; and

(e) making papers with the pulp so produced.



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L1: Entry 6 of 19

File: USPT

May 12, 1998

DOCUMENT-IDENTIFIER: US 5750005 A

TITLE: Method of enhancing biopulping efficacy

Brief Summary Paragraph Right (7):

U.S. Pat. No. 5,055,159 discloses biopulping with Ceriporiopsis subvermispora. Biomechanical pulping of both hardwood and softwood chips with this white-rot fungus has been demonstrated. During this process at a laboratory scale, fungal pretreatment of both hardwood and softwood species saves substantial amounts of the electrical energy during refining, improve paper strength, and reduce the environmental impact of pulping (Akhtar, et al., "Biomechanical pulping of loblolly pine with different strains of the white-rot fungus Ceriporiopsis subvermispora," Tappi J. 75:105-109, 1992; Akhtar, et al., "Biomechanical pulping of loblolly pine chips with selected white-rot fungi," Holzforschung 47:36-40, 1993; Akhtar, et al., "Biomechanical pulping of aspen wood chips with three strains of Ceriporiopsis subvermispora," Holzforschung 48:199-202, 1994; Kirk et al., "Biopulping: A Glimpse of the Future?", Res. Rep. FPL-RP-523, Madison, Wis., pp. 74, 1993). These results show the technical feasibility of biopulping.

Detailed Description Paragraph Right (5):

Separately from the chips, a seed inoculum must be maintained of a white rot fungal culture to be utilized during the biopulping process. The preferred culture is any useful strain of the fungal species Ceriporiopsis subvermispora, with one preferred strain being strain CZ-3 available from the Center for Forest Mycology Research of the Forest Products Laboratory, U.S. Department of Agriculture. Almost all other strains of Ceriporiopsis subvermispora are suitable for the present invention. Other preferred strains are the haploid Ceriporiopsis subvermispora strains FP-105752 SS-4, L-14807 SS-1, L-14807 SS-3, L-14807 SS-S, and L-14807 SS-10 which are also obtainable from the Center for Forest Mycology Research, USDA Forest Products Laboratory, Madison, Wis. (Our experiments below demonstrate that two of the haploid strains gave more energy savings and strength improvements than the diploid CZ-3 strain.) Ceriporiopsis subvermispora strains are common in the environment and can readily be isolated from the wild.

Detailed Description Paragraph Right (6):

A second preferred culture is any useful strain of the fungal species Phlebia subserialis. The preferred strain of Phlebia subserialis for use within the present invention is known as HHB7099. Under many biopulping processes and conditions, Phlebia subserialis offers results in terms of energy savings and improvement in wood quality that rival, in many cases, those which can be achieved with Ceriporiopsis subvermispora. Other strains of Phlebia subserialis are believed useful as well.

Detailed Description Paragraph Right (44):

Fungus: The biopulping fungus Ceriporiopsis subvermispora strain CZ-3 was used. This culture was obtained from the Center for Forest Mycology Research of the USDA Forest Products Laboratory, Madison, Wis. The culture was continuously maintained in cereal culture and potato dextrose agar slants. Working cultures were prepared from the stock cultures as needed and refrigerated until used. Potato dextrose agar plate culture was inoculated from a working culture and incubated at 27.degree. C. and 65% relative humidity for 10 days.

Detailed Description Paragraph Right (67):

Objective: To compare haploid strains with that of the best diploid strain of Ceriporiopsis subvermispora (CZ-3).

Detailed Description Paragraph Right (69):

Fungus: Strain CZ-3 of Ceriporiopsis subvermispora gave us good energy savings, but no strength improvements with the use of 1% corn steep liquor and 0.0005% inoculum. This strain was a diploid. In order to save energy and improve paper strength, we started screening haploid strains (single basidiospore isolates) of Ceriporiopsis

subvermispora. Five different haploid strains (FP-105752 SS-4, L-14807 SS-1, L-14807 SS-3, L-14807 SS-S, L-14807 SS-10) were obtained from the Center for Forest Mycology Research, USDA Forest Products Laboratory, Madison, Wis. Inoculum was prepared the same way as described in Example 1. The biopulping performance of these haploid strains was compared with that of diploid CZ-3 strain.

Detailed Description Paragraph Right (71):

Results: Table 4 reports the results. Diploid strain of Ceriporiopsis subvermispora (CZ-3) saved 15% of electrical energy and improved tear index by 14% compared to the control. All haploid strains performed better than the diploid strain. Two haploid strains L14807 SS-3 and L-14807 SS-5 saved 28-29% electrical energy and increased tear index by 21-22% compared to the control.

Detailed Description Paragraph Right (74):

Objective: To evaluate the biopulping performance of haploid strain of Ceriporiopsis subvermispora (L-14807 SS-3) on aspen wood chips in the presence of sterilized and unsterilized corn steep liquor.

Detailed Description Paragraph Right (79):

Objective: To evaluate the biopulping performance of haploid strain of Ceriporiopsis subvermispora (L-14807 SS-3) on loblolly pine chips in the presence of unsterilized corn steep liquor.

Detailed Description Paragraph Table (2):

TABLE 1 Energy savings and strength properties during biomechanical pulping of loblolly pine chips with Ceriporiopsis subvermispora CZ-3 (2-week incubation). Treatments Strength properties (% inoculum on Energy Burst index Tear index dry weight basis) Savings (%).sup.a (kN/g) (mNm.sup.2 /g)

Treatments	Strength properties (% inoculum on Energy Burst index)	Tear index dry weight basis	Savings (%)	.sup.a (kN/g)	(mNm.sup.2 /g)
Control	-- .62	+- .05	.sup.b 1.67	+- .13	.01
4	.63	+- .04	1.89	+- .09	.05
11	.71	+- .04	2.16	+- .20	.10
12	.74	+- .03	2.13	+- .15	.15
19	.70	+- .05	2.14	+- .15	.15

.sup.a Energy savings are calculated based on the untreated control values .sup.b Standard Deviation

Detailed Description Paragraph Table (3):

TABLE 2 Energy savings and strength properties during biomechanical pulping of loblolly pine chips with three levels of inoculum of Ceriporiopsis subvermispora CZ-3 in the presence of two levels of corn steep liquor (CSL) from Corn Products (batch E802) (2-week incubation). Strength properties Treatments Energy Burst Tear (% inoculum or CSL savings index index on dry weight basis) (%).sup.a (kN/g) (mNm.sup.2 /g)

Treatments	Energy Burst	Tear (% inoculum or CSL savings index)	index index on dry weight basis	(%).sup.a (kN/g)	(mNm.sup.2 /g)
Control	-- .65	+- .03	.sup.b 2.12	+- .20	Control + 1% CSL -- .67
18	.72	+- .05	2.17	+- .12	.001% inoculum + 1% CSL 19 .71
8	.74	+- .04	2.15	+- .11	.0005% inoculum - 1% CSL .sup.c .002% inoculum + 3% CSL 30 .76
25	.74	+- .04	2.18	+- .12	.0005% inoculum + 3% CSL 25 .82
25	.74	+- .04	2.18	+- .12	.0005% inoculum + 3% CSL 25 .82

.sup.a Energy savings are calculated based on the untreated control values .sup.b Standard Deviation .sup.c Fungus did not grow

Detailed Description Paragraph Table (4):

TABLE 3 Dry weight of CZ-3 strain of Ceriporiopsis subvermispora on sterilized corn steep liquor (CSL) (2-week incubation). Dry Weight of Treatments Fungus (mg/flask)

Treatments	Fungus (mg/flask)
CSL (dry wt. basis)	410
3% CSL (dry wt. basis)	1050

1%

Detailed Description Paragraph Table (5):

TABLE 4 Energy savings and strength properties during biomechanical pulping of loblolly pine chips using .0005% inoculum (dry weight basis) of diploid (CZ-3) and haploid strains of Ceriporiopsis subvermispora in the presence of 1% corn steep liquor from Corn Products (batch E802) (2-week incubation). Strength properties Energy Burst Tear savings index index Treatments (%).sup.a (kN/g) (mNm.sup.2 /g)

Treatments	Energy Burst	Tear savings index	index index	Treatments (%)	.sup.a (kN/g)
Control	-- .69	+- .05	.sup.b 2.07	+- .13	CZ-3 15 .67
15	.67	+- .05	2.37	+- .09	FP-105752 SS-4 22 .68
18	.65	+- .05	2.35	+- .13	L-14807-SS-3 29 .67
28	.63	+- .04	2.53	+- .12	L-14807-SS-10 22 .68
28	.63	+- .04	2.53	+- .12	L-14807-SS-10 22 .68

.sup.a Energy savings are calculated based on the untreated control values .sup.b Standard Deviation

Detailed Description Paragraph Table (6):

TABLE 5 Energy savings and strength properties during biomechanical pulping of aspen wood chips using .0005% inoculum (dry weight basis) of L-14803 SS-3 haploid strain of *Ceriporiopsis subvermispora* (Treatment) in the presence of sterilized and unsterilized 1% corn steep liquor (CSL) from Corn Products (batch E802) (2- and 4-week incubation). Strength properties Energy Burst Tear savings index index Treatments (%) .sup.a (kN/g) (mNm.sup.2 /g)

2-week incubation Control	--	1.01	+-	.05	sup.b																
2.16	+-	.20	Treatment (sterilized CSL)	15	1.11	+-	.07	2.49	+-	.16	Treatment (unsterilized CSL)	13	1.11	+-	.04	2.37	+-	.23	4-week incubation Control	--	1.08
+-	.04	2.14	+-	.12	Treatment (sterilized CSL)	35	1.33	+-	.05	3.13	+-	.20									
Treatment (unsterilized CSL)	37	1.31	+-	.07	3.16	+-	.14														

.sup.a Energy savings are calculated based on the untreated control values .sup.b Standard Deviation

Detailed Description Paragraph Table (7):

TABLE 6 Energy savings and strength properties during biomechanical pulping of loblolly pine chips using .0005% inoculum (dry weight basis) of L-14803 SS-3 haploid strain of *Ceriporiopsis subvermispora* (Treatment) in the presence of unsterilized 1% corn steep liquor from Corn Products (batch E802) (2-week incubation). Strength properties Burst Tear Energy index index Treatments savings (%) .sup.a (kN/g) (mNm.sup.2 /g)

Control	--	.61
+-	.05	sup.b
1.81	+-	.12
Treatment	38	.70
+-	.04	2.73
+-	.14	

.sup.a Energy savings are calculated based on the untreated control values .sup.b Standard Deviation

Detailed Description Paragraph Table (8):

TABLE 7 Dry weight of L-14807 SS-3 haploid strain of *Ceriporiopsis subvermispora* on sterilized and unsterilized corn steep liquor (CSL) (2-week incubation). Dry weight of Treatments fungus (mg/flask)

Sterilized CSL	425
Unsterilized CSL	190

Other Reference Publication (3):

Akhtar, et al., "Biomechanical pulping of loblolly pine with different strains of the white-rot fungus *Ceriporiopsis subvermispora*," TAPPI J., 75:105-109 (1992).

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